FINAL REPORT

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HYBRID POPLAR PLANTATIONS AS AN ALTERNATIVE CROP

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Hybrid poplar plantations as an alternative crop

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Final Report Submitted by:

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Summary

This project was undertaken because hybrid poplar varieties, developed at the Shelterbelt Centre and other institutions over many years, have been continuously evaluated and have been found to be easily the fastest-growing trees on the prairies. As wood supplies in natural forests become fully allocated, there may be a need for a renewable and sustainable supply of managed wood. Plantation forestry (termed "afforestation") also has value in helping Canada meet its international commitments to reduce net emissions of greenhouse gases. Although poplar and other tree species have been grown in plantations throughout the world and plantation forestry is an accepted practice in many countries, no known commercial-scale plantations existed in Saskatchewan prior to this project.

The objectives of the project were as follows were to: 1) develop block plantations of promising hybrid poplar clones for research and demonstration under Saskatchewan conditions and 2) determine which poplar varieties performed best in plantations.

Six sites were originally selected for 6-hectare (15-acre) plantations. Of these, four plantations were successfully established and three were monitored for growth. Each plantation included 3 blocks of 2 hectares (5 acres) each for a) clonal evaluation, b) yield monitoring and c) spacing comparison.

Weed control proved to be the biggest challenge in establishing these plantations. The main variables were the level of site preparation done, the machinery available for maintenance, the resources available from the cooperators, the soil and weather conditions and the local weed spectrum. The main lesson learned was that hybrid poplar needs to be established through rather intensive management. The site should be prepared in the previous year and perennial weeds like Canada thistle and quackgrass should be dealt with before planting. Since the first year of poplar growth is greatly affected by weed competition, effective pre-planting weed control herbicide was very helpful to the trees in the first year. Ineffective weed control in the first summer meant that many trees, although alive, were difficult to find and made cultivation difficult or impossible. Straightness of tree rows during planting was also critical since it could limit the equipment that could be used for maintenance. At a 2.4m X 2.4m spacing (8' X 8'), equipment accessibility was often a problem by the second or third year. A small tractor with a cultivator was essential but cultivation resulted in damaged roots in several cases so that cultivation should be as shallow as possible.

Growth of the trees was dependant on the weed control but dry years, soil conditions (texture and moisture) and early or late frosts also contributed to highly variable growth rates in the first 4-6 years. For Walker poplar which was the best-performing variety, the annual height growth at the Lakeland Harvesters site at Meadow Lake was 0.7 m/yr over 5 years in the "yield test", planted in 1998, to 1.1 m/yr over 6 years, in the "spacing test", planted the previous year (1997). The difference was attributed to d a difference in weed control intensity and weather conditions in the year of planting.

Pest surveys, conducted in 2000 and 2001, indicated that low temperature injury had the greatest effect on the hybrid poplar at the three plantations monitored. Low temperature injury was most pronounced at the Henribourg site in 2000 and Birch Hills site in 2001. Prairie Sky was the most susceptible clone to low temperature injury. Walker appears to be the least susceptible clone to low temperature injury as it had no low temperature injury at Meadow Lake, whereas all other clones had severe injury ratings. Spring frost damage was low at all plantations in 2001. In 2000 insect populations were low at all sites. Several insect pests were recorded causing light to moderate damage during the 2001 pest surveys. The gray willow leaf beetle ccaused damage during the June survey, leafminers were common during the July survey and aphids were present during the September survey. Overall, populations of the insects was low and caused minimal damage to the hybrid poplars. Melampsora leaf rust occurred late in the growing season, causing little damage. Of the five hybrid poplar clones, Manitou appears to be the most susceptible to melampsora leaf rust

The successful sites will continue to be monitored by the Shelterbelt Centre and the cooperators over the next 15-20 years and will continue to be used for research projects and technology transfer initiatives.

Hybrid poplar plantations as an alternative crop

John Kort

Funded by: Canada-Saskatchewan Agri-Food Innovation Fund (AFIF) and SaskPower

Objective: To develop block plantations of promising hybrid poplar clones for demonstration and future research of harvest yield, optimum spacing and suitable clones under Saskatchewan conditions.

Partners: Canada-Saskatchewan Agri-Food Innovation Fund (AFIF), SaskPower, Mistik Management, Weyerhaueser, Lakeland Harvesters, Terry Tomtene

Keywords: *hybrid poplar, plantations, Saskatchewan, clone, spacing, yield*

Introduction

Interest in using hybrid poplars as feedstock for OSB (oriented strandboard) and pulp mills has increased recently. Its wood quality compares favourably to trembling aspen for OSB and pulp production. As well, hybrid poplar is well suited for lumber and value-added products such as hardwood flooring, paneling, and furniture. Hybrid poplar clones selected for local conditions have been planted in commercial plantations in Ontario, Minnesota, Washington and British Columbia. In Saskatchewan, hybrid poplars have been tested in field shelterbelts but no plantations for commercial use existed at the time of s project. With this project, hybrid poplar plantations were established for demonstration and future research of harvest yields, optimum spacing and suitable clones for the Boreal Transition Ecoregion of Saskatchewan.

Methods

This was a three year project in which 36 ha (90 acres) of hybrid poplar were planted in block plantations over six sites across the parkland belt of Saskatchewan. Each site was approximately 6 ha and was split into three tests - clonal, yield and spacing tests. In the clonal test, 5 different clones (Walker, Assiniboine, Manitou, Canam and Prairie Sky) were planted in small plots (50 trees/plot) which were replicated throughout the test. The yield test contains Walker, Assiniboine and Manitou clones in large plots of 0.3 ha each, duplicated within the test. The spacing tests contain Walker and Assiniboine at three different spacings (2.4m x 2.4m, 3m x 3m and 3.7m x 3.7m) in replicated plots of 0.3 ha each.

The cooperators provided the land, prepared the planting sites and were responsible for maintenance such as weed control. Sites were marked on a grid, flagged and trees planted by hand. For various reasons related to site preparation, establishment and weed management, only three of the plantations were considered to be successful enough for follow-up measurements.

The cooperators and planting dates for these three sites are listed in Table 1.

Table 1:
Planting sites and years for hybrid poplar plantations in Saskatchewan

Cooperator	Site Location	Land Location	Planting Year		
			Clonal Test	Spacing Test	Yield Test
Lakeland Harvesters	Meadow Lake	NW 2-58-19 W3	1998	1997	1998
Terry Tomtene	Birch Hills	SW 3-47-23 W2	1999	1999	1998
Weyerhaeuser Canada Ltd.	Henribourg	NW 26-51-25 W2	1998	1997	1998

In 2000 and 2001, a poplar pest survey was conducted. Surveys were conducted three times at four sites to monitor insect, disease and environmental damage. Surveys were conducted at the Lakeland Harvesters, Tomtene and Weyerhaeuser plantations. During each survey, between 100 and 150 trees at each plantation were examined.

Results

Figure 1. 5-year-old Walker poplar at Henribourg

Data analysis was done at three of the original six plantations. The total growth of the hybrid poplar trees was measured in the fall of 2002 and means for each clone were calculated (Table 2). Walker had the overall greatest amount of growth. The difference among sites in the order of tree heights may be due to site conditions and weather differences. In subsequent years, differences will likely become more significant as clones develop to their genetic potentials. Walker poplar was the fastest-growing variety overall. Measurement at 5 years of age (Lakeland Harvesters and Weyerhaeuser) and 4 years (Tomtene) is a preliminary measurement only as it takes several years for trees to get established and variable events such as frost or drought can influence results greatly. Growth measurements at 10, 15 and 20 years will be more useful since the time projected to harvest based on growth rates of poplar trees in shelterbelts is 20 to 25 years. A DBH of 20 cm would be desirable for harvest.

Table 2:
2002 measurements of mean tree height (m) and diameter at breast height (DBH) (cm) of hybrid poplar in clonal tests

	Assiniboine		Canam		Manitou		Prairie Sky		Walker	
	Ht (m)	DBH (cm)	Ht (m)	DBH (cm)	Ht (m)	DBH (cm)	Ht (m)	DBH (cm)	Ht (m)	DBH (cm)
Lakeland Harvesters (1998)	2.67	2.13	2.96	1.98	2.58	1.99	2.38	1.60	3.61	3.32
Weyerhaeuser (1998)	4.28	3.82	3.70	2.96	3.71	3.58	3.60	2.86	5.17	5.27
Tomtene (1999)	2.75	1.86	3.00	2.16	2.17	1.76	2.38	1.33	2.87	2.14
Average	3.23	2.60	3.22	2.37	2.82	2.44	2.79	1.93	3.88	3.58

The height and DBH of Walker poplar trees in the spacing tests were measured and recorded in the fall of 2002 (Table 3). The effect of spacing on growth was not evident at this time since there was no significant difference between the tree heights. At the age of 6 years and 5 years, the trees had apparently not yet begun to compete with each other significantly so that the distance between treees was not yet a factor in their growth.

Table 3:
2002 measurements of mean tree height (m) and DBH (cm) of Walker poplar in spacing tests.

	2.44m X 2.44m		3.00m X 3.00m		3.66m X 3.66m	
	Ht (m)	DBH (cm)	Ht (m)	DBH (cm)	Ht (m)	DBH (cm)
Lakeland Harvesters (1997)	6.36	6.00	6.67	6.65	6.47	6.70
Weyerhaeuser (1997)	4.91	4.44	5.64	5.65	5.05	4.91
Tomtene (1999)	3.21	2.54	3.06	2.44	3.45	2.82
Average	4.83	4.33	5.12	4.91	4.99	4.81

Conclusions and Discussion:

With the establishment of these plantations, growth data and potential yields of hybrid poplar can be determined at 15, 20 and 25 years of age. The best clone and the optimum spacing can then be determined for hybrid poplar plantations grown under Saskatchewan conditions.

Important lessons were learned from this project

1. Although innovative establishment and maintenance practices may be developed, hybrid poplar requires vegetation-free soil to achieve its best growth.
In one site, site preparation consisted of chemical control with glyphosate of perennial vegetation and was followed by hand-planting into undisturbed soil by lifting the sod with a planting shovel and planting the trees into the underlying mineral soil. Because of poor root-to-soil contact and regrowth of annual vegetation, the trees did not survive the first season. In another site, a forest soil preparation method was used for site preparation including the scalping of sod with a large plow so that trees could be hand-planted into the underlying mineral soil. Although most trees survived the first year because of good soil moisture, regrowing natural vegetation choked out most of the trees by the end of the second year. At the Weyerhaeuser site, grass was under-seeded in the five acre spacing trial in the year of planting for ease of maintenance. Although the trees survived and grew in height as quickly as the trees which were kept cultivated, diameter growth and biomass growth was very much less than the other trees in the same site. At the Lakeland Harvesters site at Meadow Lake, the spacing trial was planted a year earlier than the other components and received better weed control. After 6 and 5 years of growth, respectively, there is a great and apparent difference in growth between these blocks.

Figure 2. 6-year-old Walker poplar in spacing trial at Henribourg, undersown to grass.

2. Shallow rooting of poplar trees limits maintenance options.
Deep tillage (ie. more than 5 cm) is likely to damage the roots, making the trees more susceptible to disease, insects, cold damage and drought and restricting their growth. It may also result in suckering from the damaged roots.

3. All the varieties of hybrid poplar tested were susceptible to winter or frost damage.
Hybrid poplar trees are especially susceptible to dieback due to late spring frost (2000) and early fall frost (2002). The faster growing varieties are at least partially so because of their use of the full growing season, with early budbreak and late leaf drop. This makes them susceptible in spring and fall even though they can withstand severe winter temperatures. Freezing damage and drought damage normally involve loss of part or all of the current year's growth and can include the loss of previous years' growth as well for poorly adapted varieties. Dieback may be completely to the ground followed by vigorous growth from the root in the next growing season. For better-adapted varieties, some top dieback was overcome quickly in the following year(s). It is critical that varieties are used in plantations that are relatively well adapted to the local climate.

4. Drought restricts hybrid poplar growth severely.
Hybrid poplar can grow quickly but need a lot of water to do so. In high moisture years, height increases of 1-2 m may be expected in young plantations but the Meadow Lake plantation (Lakeland Harvesters) experienced severe drought in 2002 and the annual height increment in many trees was less than 20 cm.

The successful plantations at Meadow Lake (Lakeland Harvesters), Henribourg (Weyerhaeuser) and Birch Hills (Terry Tomtene) have been very important for other developments and projects related to growing and managing poplar plantations.

1. Terry Tomtene (Birch Hills) - About 150 Walker poplar trees that were not part of the yield test but were planted adjacent to it, were cut to the ground in 2000, after 3 years of growth to produce some cuttings stock for Saskatchewan Environment's new plantation demonstration program.

2. Weyerhaeuser (Henribourg) - Walker poplar under-sown to grass has grown more poorly than the clean-cultivated tests. However, the trees are tall, have very straight stems (i.e. a good form) and have not suffered from winterkill as the other tests have, likely because the stress they are under causes earlier dormancy in the fall. In this test, a recent study has been begun in which grass is being killed in some plots. It may be that early underseeding to grass to improve form and prevent winterkill, followed by removal of the grass in a later year will result in trees of high quality with a lower establishment cost, even though a year or more of growth is sacrificed by the practice.

3. Weyerhaeuser (Henribourg) - A recent study, funded through the Saskatchewan Agriculture Development Fund is focused on the use of hybrid poplar plantations as a way to safely dispose of excess nitrogen from swine barn effluent. The Henribourg plantation is being used for a nitrogen uptake study in which different rates of granular fertilizer are applied.

4. Lakeland Harvesters (Meadow Lake) - The University of Saskatchewan is conducting studies on nutrient cycling and growth rates in this plantation.

5. Lakeland Harvesters (Meadow Lake) - A pruning trial was carried out in the Walker poplar plots (spacing test and yield test) in the winter of 2000/2001 to develop recommendations. The yield test was only 3 years old and resprouted suckers from the base while the spacing trial was 4 years old and no regrowth at the base was noted. Pruning was to a height of 2 metres for both which was too much for the younger plots (i.e. too much of the crown was removed) but was less than half of the crown material for the older trees. Although the effect on wood quality is not known, a single pruning after 4 years appears to be effective and not harmful to the trees. It also makes for easy access for subsequent weed control.

6. Lakeland Harvesters (Meadow Lake) and Weyerhaeuser (Henribourg) - Both sites have been frequently used for tours.